Sedimentological and Ichnological Assessment of a Regional Sequence Boundary/Transgressive Ravinement Surface, Bluesky-Gething Interval, northern Alberta

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A sequence boundary/transgressive ravinement surface in the Lower Cretaceous Bluesky–Gething interval present across a vast area of northern Alberta has been examined and correlated in a series of drill-cores (Fig. 1). The primary objective of the study is to demonstrate the widespread nature of the surface and characterize the variation in its sedimentological and ichnological expression. Lateral facies changes in the stratigraphy immediately above and below the surface make it difficult to reliably delineate in wireline logs in all well penetrations. As such, detailed core examination is required in order to better constrain the stratigraphic architecture of the Bluesky–Gething interval and thus develop predictive depositional models. The interval of interest is variably a natural gas, light crude oil, and heavy oil reservoir target across the vast study area (e.g., Boyer, Panny and Red Earth fields).

The Bluesky and Gething formations were deposited in an intracontinental seaway during an overall southward transgression during the Aptian–Albian (Leckie and Smith, 1992). The area studied was mostly bound to the south, west and east by a series of emergent highlands, within a broad shallow basin that opened to the Boreal Sea to the north (Fig. 1). The stratigraphic surface assessed in this study, from areas proximal to the paleo-islands (e.g., Keg River and Red Earth Highlands) to more distal areas northward, is characterized by: (1) roots, coally material and pebbly debris; (2) robust, passively-filled burrows of the *Glossifungites* Ichnofacies, as well as pebbly debris and glauconite locally; and (3) glauconitic sandstone with local evidence for the *Glossifungites* ichnofacies (Fig. 2). In some instances the surface is delineated by a sharp lithological contact, typically consisting of sandstone overlying finer-grained strata. South of the Red Earth Highlands in the Cadotte area, Hubbard et al. (1999) demarcated a lithostratigraphic boundary in roughly the same stratigraphic position as the surface studied, separating an underlying fine-grained brackish seaway deposit from an overlying estuarine to marine sandstone-prone interval. In the Seal region south of the same highland, Anderson and Hubbard (2008) recognized this important stratigraphic boundary by a widespread coally deposit. South of the Keg River Highland, the surface is demarcated by firmground burrows of the *Glossifungites* ichnofacies and abundant glauconite (Male, 1992).

Roots developed on the surface in proximal areas of the marine seaway, adjacent to paleo-islands, indicate that its genesis involved a sea-level fall associated with subaerial exposure. Sea-level fall likely contributed to the exhumation of widespread firmground substrates both subaerially and subaqueously, which were suited to colonization by opportunistic burrowers; passively-filled trace fossils of the *Glossifungites* ichnofacies identified include *Arenicolites*, *Diplocraterion*, and *Skolithos* (Fig. 2). The sea-level fall was also likely associated with influx of gravel-sized sediment to the basin. During subsequent sea-level rise, transgressive ravinement is indicated by the presence of extensive glauconitic sand and winnowed pebbly and granular units on the surface.

The sequence boundary/transgressive ravinement surface records an important shift in basin paleogeographic and paleoecologic conditions. The underlying units are generally siltstone dominant, and ubiquitously characterized by low diversity trace fossil suites (3-4 forms on average) consisting of simplistic marine (ie, brackish-water trace fossil model; Pemberton et al., 1982). Units that overlie the stratigraphic surface are associated with a mappable trace fossil diversity gradient. In areas adjacent to paleo-islands (ie, in proximity to freshwater point sources), trace fossil suites are characterized by low-diversity (3-7 forms on average), including *Cylindrichnus*, *Gyrolithes*, *Paleophycus*, and *Planolites*. More distally relative to the paleo-islands, northward towards the direction of marine incursion into the basin, trace fossil diversity increases substantially (up to 16 forms) and burrows record more complex feeding behaviors (e.g., *Macaronichnus*, *Phycosiphon*, *Scolicia*, and *Shaubcylindrichnus*).

The cores selected for this presentation emphasize the variable expression of the sequence boundary/transgressive ravinement surface in the Bluesky-Gething interval (Fig. 2). The surface represents an important means to map the stratigraphic architecture of an especially important hydrocarbon-bearing interval in the Alberta Basin.

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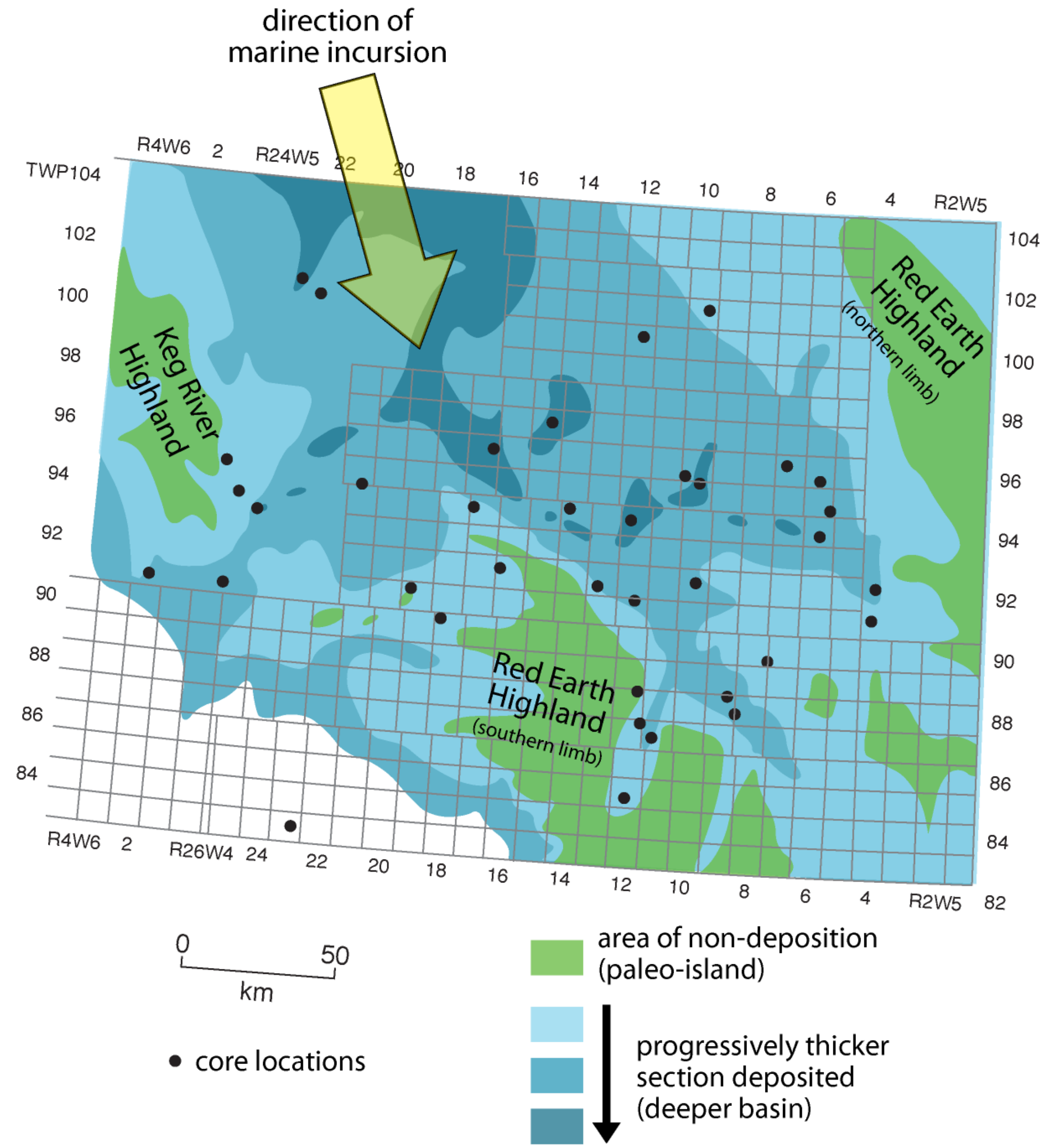

Figure 1. Study area map with paleogeographic aspects indicated. During deposition of the Bluesky-Gething interval, the setting was characterized by a chain of emergent highlands with the basin open to the Boreal Sea to the north. The distribution of cores examined in indicated.

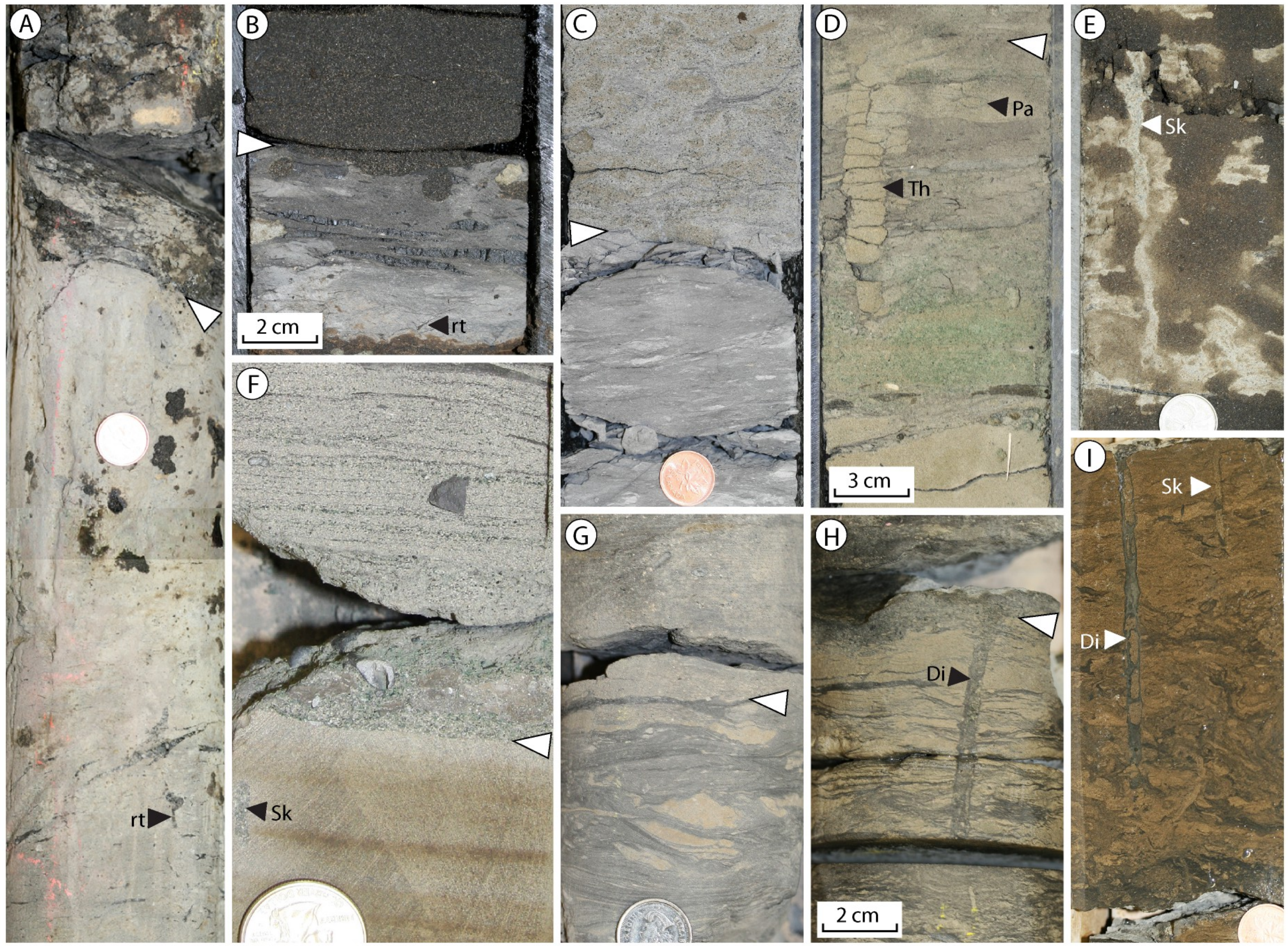

Figure 2. Sedimentological and ichnological characteristics of stratigraphic surface studied. (A) Roots (rt) underlying a pebble lag (08-17-087-11W5; 467 m). Note that large white arrows denote stratigraphic surface of interest in all photographs. (B) Roots (rt) and coaly debris below passively filled horizontal burrows (13-26-091-04W5; 377.7 m). (C) Bioturbated glauconitic sandstone overlying surface (04-10-094-06W5; 379.1 m). (D) Robust, passively filled *Thalassinoides* (Th) cross-cutting multiple glauconite-rich laminae (05-32-096-07W5; 308.8 m). (E) *Skolithos* (Sk) passively filled with glauconitic sandstone (10-03-092-13W5; 686.7 m). (F) Glauconitic, planar laminated sandstone with granular lag overlying the stratigraphic contact (03-06-096-07W5; 605 m). (G) Subtle shell debris and granule lag (07-27-096-17W5; 337.7 m). (H) *Diplocraterion* (Di) descending from the stratigraphic surface (10-03-095-21W5; 249 m). (I) Passively filled, *Skolithos* (Sk) and *Diplocraterion* (Di) (10-02-091-25W5; 629.7 m).